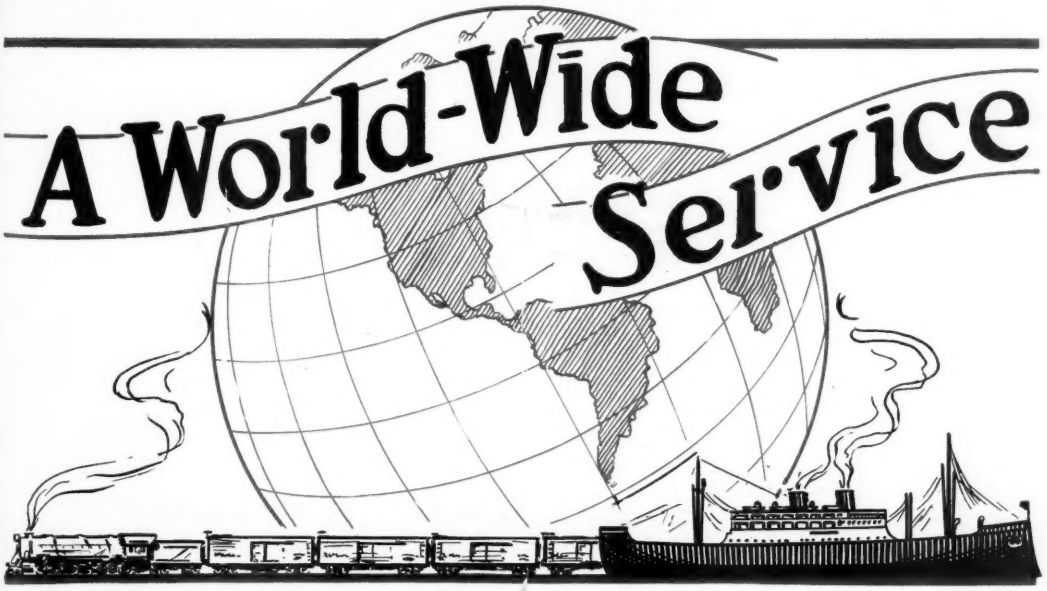
The American Fertilizer

94 JANUARY 4, 1941 No. 1



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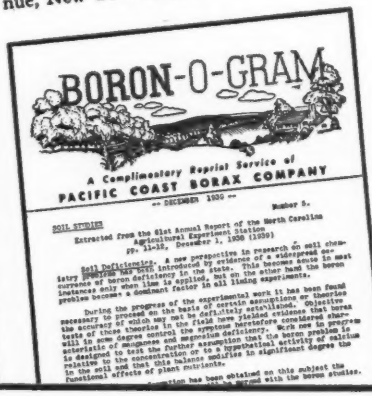
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-- DECEMBER 1930 --

Number 5.

SOIL STUDIES

Extracted from the 41st Annual Report of the North Carolina Agricultural Experiment Station
pp. 11-12, December 1, 1928 (1930)

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Vol. 94 JANUARY 4, 1941 No. 1

Phosphorus in Human and Animal Health*

By TOM S. HAMILTON

Associate Professor of Animal Nutrition, University of Illinois, Urbana, Ill.

I. Introduction

Phosphorus is one of at least a dozen mineral elements definitely known to be required by animals and man for normal growth, health, reproduction, and continued life. About three-quarters of one per cent of the live weight of an animal is phosphorus. On this basis a 170-lb. man contains about 1.25 lb. of phosphorus and a 1000-lb. steer would contain about 7.5 lb. The only mineral element that is present in the body to a greater extent than phosphorus is calcium, there being about twice as much calcium as phosphorus. Calcium and phosphorus combined make up about 2 per cent of the live weight, or about 65 per cent of the mineral content, of the body. Nearly all, about 99 per cent, of the calcium and 80-85 per cent of the phosphorus is in the skeleton. Thus while there is but one per cent of the calcium, there is 15-20 per cent of the phosphorus in the soft tissues. This fact is significant and might be taken as an indication that phosphorus might play a wider and more varied role in body processes than does calcium — and this is actually the case.

II. Functions of Phosphorus in the Body

Of the thirteen mineral elements now known to be essential to animal life, phosphorus unquestionably enters into a greater number of chemical reactions and is a necessary constituent of a larger number of compounds in the body than any other mineral element. From a quantitative point of view, the chief use of phosphorus is, in combination with calcium, to confer rigidity to the bones. The bones not only make speech and locomotion possible, but they also serve the very important function of serving as a calcium and phosphorus reserve—a reserve which may be called upon to furnish these elements for more important functions whenever the food fails to supply a sufficient quantity.

In the soft tissues of the body, phosphorus is found widely distributed and serving a wide variety of functions. In fact, every cell in the body contains phosphorus. The cells of the body are the regulators of all body processes and the master portion of each cell, the nucleus, is rich in phosphorus. All muscle and glandular tissues are rich in phosphorus. In these tissues phosphorus is combined with protein to form compounds called phosphoproteins. This is the explanation of the fact that materials rich in protein are usually rich in phosphorus. No tissue in the body is so rich in ether-soluble material as are the nerves and brain, yet this lipoidal material is not neutral fat but is a combination of phosphoric acid and certain lipoidal substances or fats—the combinations being referred to as phospholipids. The stimulation which causes our muscles to contract is associated with the decomposition of phosphocreatine, an easily hydrolyzable compound of creatine and phosphoric acid. Phosphoarginine, a phosphoric acid ester of arginine, serves a similar function in crustaceans.

Phosphorus, chiefly as phosphoric acid, is an intermediary in carbohydrate metabolism. It has also been suggested that the intestinal absorption of glucose is increased by the presence of phosphate. Also the difference in the rates

* A paper given before the Western Phosphate Conference, held at Ogden, Utah, September 5 and 6, 1940.

of absorption of hexoses and pentoses has been explained on the basis that the former are esterified with phosphoric acid, while the latter are not. The transformation of glycogen into lactic acid is accomplished by a complex enzyme system in which adenylic acid—a compound containing adenine, ribose, and phosphoric acid—is an important factor. In the oxidation of carbohydrates (glucose)—a process which furnishes us with much of the energy which enables us to do work—a temporary combination of phosphoric acid and the carbohydrate is the starting point. In the oxidation of fats, too, it is necessary for them to combine with phosphoric acid before oxidation starts. Certainly very little energy would become available for our use in the absence of phosphorus.

When food fats are digested and enter the blood stream, they are quickly phosphorized or combined with phosphoric acid. This change is a very necessary one, for neutral fats are insoluble in the blood and they would form groups or colloids which would be entirely too large to pass through the blood capillaries, much less pass through cell membranes. Disastrous results would soon follow the formation of fat colloids in the blood stream. Nature's way of taking care of this situation is to cause the neutral fats, on entering the blood stream either from the intestinal tract or from the fat depots of the body, to combine with phosphoric acid (and choline) to form a compound called lecithin. This substance is soluble in the blood and in this form fats are transported throughout the body. We know also that the body has the ability to change, to a certain extent at least, food fat into fat characteristic of the body. Lecithin—that is, a phosphorized fat—is an intermediary in this process.

Phosphorus is also a necessary intermediary in the transformation of carbohydrates into fats. Thus the fattening of our farm animals, since the source of body fat is chiefly carbohydrates, depends upon the presence of phosphoric acid. Phosphorus plays a similar role in the formation of milk fat. This possibly explains the marked decrease in milk production of cows suffering from a phosphorus deficiency.

So far we have emphasized only the organic forms of phosphorus, but this element is no less prevalent and equally important in many inorganic combinations. Aside from the combinations of phosphorus and calcium, and to a much smaller extent, phosphorus and magnesium in the bones, phosphorus, chiefly as phosphates of sodium and potassium, is widely distributed especially in the fluids of the body. In the blood stream and cellular fluids, they are among the most important buffers in the body. The buffers of the body maintain the proper hydrogen-ion concentration. All body processes depend so much upon the maintenance of the proper hydrogen-ion concentration that any very great deviation from that which is normal is disastrous. Also one of the chief mechanisms, involved in the absorption of food nutrients from the intestinal tract into the blood stream, is the passage of these nutrients into the lymph and thence into the cells of the body is osmotic pressure. Waste products of cell metabolism are eventually discarded through the excretory organs of the body largely with the aid of osmotic changes. The soluble phosphates again are important factors in controlling these changes in osmotic pressure.

Phosphates are referred to as co-enzymes in certain digestive juices. For example, saliva dialyzed free of phosphates loses its power to digest starch.

It is no wonder that a phosphorus deficiency in animals is manifested in a variety of ways and so seriously affects the health and productive activities of the animal.

III. Phosphorus Metabolism

Since phosphorus plays such important roles in so many body processes, to discuss phosphorus metabolism adequately would include a discussion of almost the entire field of nutrition. For the purpose of the present discussion, since reference has already been made to the functions of phosphorus in the body, brief mention of a few facts concerning phosphorus metabolism would seem to be sufficient Metabolism, as you know, includes all changes which a nutrient or element undergoes from the time it enters the blood stream until it is excreted from the body.

Now a mineral element such as phosphorus is quite different from an organic nutrient such as glucose or fat. When glucose or fat is oxidized, carbon dioxide, water and energy result. While water may or may not be used, carbon dioxide is of no use and is soon discarded. The energy, after serving the purpose for which it was produced, soon leaves the body as heat. Phosphorus, on the other hand, is not worn out after having been used once but is just as good and as useful as before. After being liberated from serving one process, it may be used over and over, entering successively into one process after another. This explains why the body, so long as it is to live, must have a continuous and comparatively large intake of energy-producing nutri-

ents, and also why the adult animal requires such small amounts of the mineral elements such as phosphorus. There is an inevitable loss of mineral elements from the body daily, and although this may be small, it must be made good by the food; otherwise the body stores gradually become depleted and disastrous results ultimately follow.

Many forms of both organic and inorganic phosphorus can be used by the body. However, before any kind of phosphorus can be used by the body, it must first be digested or changed into a soluble form—providing, of course, it is not already in that form. Only to the extent that food phosphorus is changed in the digestive tract into a soluble form (usually a phosphate) can it be absorbed and used by the body. In case of inorganic phosphates, chemical solubility or insolubility is not a very good index of the extent to which they will be absorbed. For example, tricalcium phosphate, which is only slightly soluble in water, is quite a good source of calcium and phosphorus to the animal. In the case of organic forms of phosphorus, only to the extent to which they are hydrolyzed in the digestive tract are they absorbed and utilized by the animal. The cereal grains, for example, are fairly rich in total phosphorus, but between 50 and 70 per cent of this is an organic combination called phytin, a compound which is hydrolized with extreme difficulty in the digestive tract. For this reason the phosphorus of the cereal grains is utilized only to the extent of 50 per cent or even less. This also is at least a partial explanation of the so-called ricket-producing effect of the cereals. Vegetables, on the other hand, contain little or no phytin and their phosphorus is utilized quite completely.

Also it is possible for very soluble forms of phosphorus to be rendered insoluble in passing through the digestive tract. Alkaline conditions in the intestines favor the formation of insoluble phosphates, particularly in the presence of large quantities of iron and aluminum, or even calcium.

In the growing animal most of the absorbed phosphorus is deposited in the skeleton. For the proper mineralization of the growing bone, a rather delicate balance of calcium, phosphorus and vitamin D is required. Since calcium and phosphorus are deposited in the bone in about the same proportion as they occur in tricalcium phosphate, i. e., about 2 parts of calcium to one of phosphorus, and since 99 per cent of the calcium and 80-85 per cent of the phosphorus of the body are in the bones, it may be seen that the optimum ratio of calcium to phosphorus in the food of a growing animal should be a little less than 2:1. In fact a satisfactory ratio seems to be anywhere between 2:1 and 1:2. When the proportion of calcium to phosphorus is between these limits, the amount of vitamin D required is small. However, when the ratio exceeds these limits, either one way or another, the amounts of vitamin D must be increased in order to promote proper calcification. Of course, beyond certain rather wide disproportions of calcium and phosphorus, no amount of vitamin D is efficacious. It should be remembered also that the actual amounts of calcium and phosphorus, in proportion to the animal's requirements, are just as important as is the exact ratio. For example, a diet which will readily produce rickets in a rapidly growing animal may not produce rickets at all in a more slowly growing one.

The blood stream normally contains between 35-45 mgm. phosphorus per 100 cc. Some of this is in organic and some in inorganic form. By a rather complicated interrelationship of hormones and enzymes, the inorganic content of the blood is maintained fairly accurately between 4-9 mgm. per 100 cc. of plasma so long as either the food or skeleton will supply the necessary amount of phosphorus. A prolonged phosphorus deficiency invariably causes a decrease in the inorganic phosphorus in the blood. So long as the food furnishes a sufficient amount of phosphorus to maintain the normal amount in the blood stream, none of the body stores are withdrawn. When there is an insufficient amount in the food, phosphorus is mobilized from the bones to make up the deficit. A considerable percentage of the bone phosphorus may be withdrawn without any deleterious effects upon the animal. When excess food phosphorus again becomes available, the reserve supply is again built up. There is perhaps a daily withdrawal and deposit of phosphorus from the bones. Also in case of heavy-producing dairy cows there is normally a period during maximum milk flow in which the phosphorus reserves may be continually withdrawn, to be made up during the period of low milk flow.

While vitamin D is absolutely necessary for calcification of growing bones, so far as is known this vitamin is not concerned with the redeposition of phosphorus or calcium into the bones. Thus vitamin D does not seem to be required by adult animals.

A few minutes ago I mentioned the fact that the presence of certain mineral elements in the intestinal tract might cause the forma-

tion of insoluble phosphates, thus preventing the absorption of phosphorus. Now a similar thing may happen in the blood stream. Beryllium, lead, selenium, and other metals form insoluble phosphates and thus an excess of phosphorus may, under proper conditions, help to retain these metals in the body—often in the bones.

Phosphorus is excreted from the body, chiefly as phosphates, either in the urine or feces. In the case of herbivora, phosphorus is excreted chiefly in the feces; in carnivora, largely in the urine; and in omnivora, it is about equally divided between the urine and feces. The partition between urine and feces may be quite readily influenced by the composition of the diet or ration.

Many interesting details of phosphorus metabolism have recently been brought to light through the use of the radioactive phosphorus isotope (P^{32}). Now this isotope of phosphorus is just like any other atom of phosphrous in all of its chemical properties. It differs from the ordinary atom of phosphorus in that it has the property of emitting β-radiations which can be used to detect its presence. Actually these phosphorus atoms are labeled or tagged, and in this way their movements in the body can be followed readily. Thus sodium phosphate containing a very small amount of its phosphorus as radioactive phosphorus, given by mouth to a rat, was found 4 hours later to be distributed as follows*:

Bones	48	per cent
Muscles	25	per cent
Digestive tract	10.8	per cent
Liver	9.8	per cent
Blood	2.4	per cent
Kidneys	2.3	per cent
Skin and hair	1.2	per cent
Spleen	0.3	per cent
Brain	0.08	per cent

The use of phosphorus isotopes has shown that phosphorus atoms once deposited in the tissues of the body—even the bones—are not permanently fixed and stable but are continually moving around and are not fixed in any one place or for any considerable length of time. For example, a particular atom of phosphorus may be in the bones at one time, then later it may appear in the blood stream, still later it may be found as one of the building stones of a muscle protein, and again it may find its way back into the bones again.

In view of the relationship of phosphorus to the metabolism of so many substances and particularly in view of the fact that both carbohydrates and fats must be temporarily combined with phosphoric acid before they can be oxidized, it is no wonder that one of the effects of a severe phosphorus deficiency is a lowered utilization of the phosphorus-deficient ration.

IV. The Phosphorus Contents of Feeds and Foods

An analysis of a single sample of a particular kind of feed or food is of very little value, no matter how accurate the analysis may have been. Even the average value for a large number of samples of the same kind must not be overrated. The phosphorus content of plants and seeds is affected by a great number of factors, and the phosphorus content of the same kind of plant or seed may vary several hundred per cent. Some of the factors which may affect the phosphorus content of plants are (1) the phosphorus content of the soil, (2) the form in which the phosphorus is present in the soil, (3) the soil type or composition, (4) the effective rainfall or irrigation water, (5) the weather, (6) the previous crop, (7) the stage of maturity, (8) the season, and (9) aridity. In general, soils low in phosphorus produce crops low in phosphorus, this being particularly true of the leaves and stems. The phosphorus content of the soil is not always a good indication as to whether or not the crop will have a normal phosphorus content, because the soil prosphorus may or may not be available to the plant. Drought and aridity both depress the phosphorus content of the crop.

The existence of so many factors affecting the phosphorus content of a crop greatly detracts from the significance of any average result. Nevertheless averages do serve to describe in a general way the feeds or foods to which they apply and afford a basis for comparing different classes of feeds or foods as a source of phosphorus.

Seeds as a class are fair sources of phosphorus. On the dry basis, the common cereals, corn, wheat, oats and barley, contain 0.3-0.4 per cent. Rice has about 0.1 per cent and soybeans may contain as much as 0.7 per cent. The seed byproducts are almost always richer in phosphorus than the seeds from which they were made. This is because the phosphorus is usually associated with the protein and not the starch or fat of the seed. When the starch and fat are removed, naturally the remaining portion will have a higher content of phosphorus. On the dry basis, corn gluten feed has about 0.85 per cent phosphorus, or more than twice

* Hevesy, G., Enzymologia, vol. 5, pp. 138-157 (1938).

(Continued on page 26)

Tag Sales for December and for 1940

Fertilizer sales in 1940 in 17 States, as indicated by the sale of tax tags, amounted to 5,496,000 tons. This represented increases of 1.5 per cent over 1939 and 4.4 per cent over 1938, but sales were still well below 1937, the peak year of the past decade.

Tag sales in the 17 States in 1939 were equivalent to 71.38 per cent of total commercial fertilizer consumption in the entire country in that year. If we apply that ratio to the tag sale figure for 1940 we arrive at an estimate of 7,700,000 tons for total consumption. This compares with 7,589,000 tons actually used in 1939, 7,489,000 tons in 1938, and 8,196,000 tons in 1937. These figures do not include the tonnage of fertilizer distributed by AAA.

It is quite possible, of course, that total consumption in 1940 was somewhat larger than 7,700,000 tons, as sales in the Northeast, in certain States in the Midwest, and in the West might have shown a somewhat larger increase than did the 17 States. There is more of an upward trend in sales in the North and West than in the South. Sales in the South were kept down somewhat by the effect of the tobacco acreage reduction in Virginia and North Carolina. Sales in the 15 other tag sale States were 6.4 per cent larger in 1940 than in 1939. If we apply this percentage increase to actual sales in the other 31 States in 1939, and add the tag sale figure, we arrive at an estimate of 7,800,000 tons.

Slight declines in tonnage from 1939 were reported by Louisiana and Oklahoma, in addition to the reductions in Virginia and North Carolina. Increases in the other eight southern States were more than sufficient to offset these declines, the net result being a 4,500 ton increase in the area as a whole. The largest gains were in Georgia, Arkansas, Tennessee, and Texas. In the three last-named States, 1940 tonnage was not only larger than in 1939 and 1938 but also topped 1937. Recovery in fertilizer consumption in Arkansas and Texas from the great 1931-1932 slump had been much slower than in other States. While total tonnage for the entire country in 1937 was practically at the 1930 level, combined 1937 tonnage in those two States was only about half as large as in 1930. Much of the lag has been made up, however, by the marked rise of the last three years.

All of the five midwestern States reported larger tag sales in 1940 than in 1939, with the

(Continued on page 24)

TAX TAG SALES, BASED ON THE 1928-30 AVERAGE AS 100

Region	1928-30	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940
South	100	74	48	57	65	72	78	97	87	89	89
Midwest	100	78	40	46	64	79	106	118	104	112	129

FERTILIZER TAX TAG SALES

State	December 1940 Per Cent of 1939	December 1940 Tons	December 1939 Tons	December 1938 Tons	Calendar Year 1940 Per Cent of 1939	Calendar Year 1940 Tons	Calendar Year 1939 Tons	Calendar Year 1938 Tons
Virginia	114	9,466	8,312	7,487	94	393,069	418,089	405,179
N. Carolina	107	50,616	47,101	57,318	89	1,076,730	1,215,887	1,104,788
S. Carolina	106	16,285	15,340	17,513	101	685,310	678,859	660,963
Georgia	174	19,358	11,153	24,916	111	762,725	689,790	768,323
Florida	77	60,756	78,677	78,264	102	568,671	556,782	555,475
Alabama	46	3,850	8,450	2,600	102	575,900	562,100	528,850
Mississippi	152	12,750	8,365	18,950	100	319,508	318,761	325,836
Tennessee	...	950	0	42	113	147,311	130,354	128,291
Arkansas	228	2,050	900	2,300	136	101,000	74,122	67,800
Louisiana	93	4,450	4,800	4,000	98	156,775	160,488	148,542
Texas	33	1,415	4,244	3,790	124	118,199	95,226	84,276
Oklahoma	117	700	600	0	97	7,363	7,622	8,005
Total South	97	182,646	187,942	217,180	100	4,912,561	4,908,080	4,786,328
Indiana	34	213	625	244	115	302,750	263,145	235,297
Illinois	50	375	750	1,061	119	51,748	43,456	43,278
Kentucky	...	0	0	324	103	123,102	120,009	109,968
Missouri	3	5	177	217	129	87,577	67,733	70,301
Kansas	521	365	70	20	125	17,931	14,366	18,099
Total Midwest	59	958	1,622	1,866	115	583,108	508,709	476,943
Grand Total	97	183,604	189,564	219,046	101	5,495,669	5,416,789	5,263,271

Trends in Fertilizer Manufacture and Usage

By H. R. SMALLEY

Head of Soil Improvement Work, National Fertilizer Association, Washington, D. C.

Abstract of talk given at Ohio Fertilizer Conference, December 12, 1940

THIS is the anniversary year of the very beginning of the commercial fertilizer industry. It was in 1840 that the great German chemist, von Liebig, addressed the British Association for the Advancement of Science and set forth his so-called mineral theory of plant nutrition. About that time Liebig treated bones with sulphuric acid, thus making the phosphoric acid more available to crops. In 1842 Sir John Lawes patented a process for making superphosphate and that was the real beginning of the commercial fertilizer industry.

I shall not take time to review in any detail the developments that have taken place during the years that have intervened, but I shall mention a few of the highlights in that development.

In 1845 von Liebig demonstrated the value of potash salts in crop production.

In 1867 the South Carolina phosphate rock deposits were discovered.

In 1869 or 1870 the first potash was imported to this country from Germany.

In 1872 the first fertilizer experiments were started at State College, Pennsylvania.

In 1881 the Florida phosphate deposits were discovered.

In 1889 the western phosphate deposits were discovered.

In 1893 the first by-product sulphate of ammonia was produced in the United States, although by-product ammonia salt had been produced in England fifty years earlier.

In 1893 or 1894 the Tennessee phosphate deposits were discovered.

In 1907 the first concentrated phosphate was made at Charleston, South Carolina.

In 1910 the production of calcium cyanamid was begun at Niagara Falls, Canada.

In 1915 the first American potash was produced from the brine of Searles Lake, California.

In 1922 synthetic nitrogen was first produced commercially in the United States.

In 1929 the first shipment of synthetic nitrate of soda was made from Hopewell, Virginia. (The first shipment of Chilean nitrate to this country was made in 1830.)

In 1931 the first shipment of potash was made from Carlsbad, New Mexico.

Up until about 1914 the nitrogen in mixed fertilizers was derived mainly from organic sources or from nitrate of soda. Now the bulk of the nitrogen in mixed fertilizers is in the ammonia form and is derived from sulphate of ammonia or from ammonia solutions.

Urea, which is now an important fertilizer material, was first synthesized in 1828, but commercial production was not achieved until about 100 years later.

Superphosphate, which formerly contained 12 to 16 per cent of available prosphoric acid, now contains 18 to 20 per cent as manufactured.

The concentration of potash salts has increased very substantially during the past 10 years.

It is fair to say that mixed fertilizers today contain more plant food per ton and are in better drilling condition than they have ever been.

Progress of Fertilizer Use in Ohio

Great changes have occurred in the use of fertilizer in Ohio during the past 20 years. In 1920, 65 per cent of the total consumption of fertilizer in Ohio consisted of phosphates, 31 per cent of mixed fertilizers, and 4 per cent of miscellaneous materials.

In 1929 the percentage of phosphate had dropped to 23, and the percentage of mixed fertilizers had risen to 74 per cent. Ten years later. in 1939, the percentage of phosphates had dropped to 11 per cent, and the percentage of mixed fertilizers had gone up to 85 per cent.

In 1920 the average mixed fertilizer sold in Ohio contained only 12 per cent of total plant food, whereas in 1939 the total plant food content was 20.5 per cent.

Of all the grades of mixed fertilizer sold in 1934 in Ohio, 56 per cent of the tonnage consisted of grades containing 20 per cent or more of total plant food. In 1939 the tonnage of

grades having a total of 20 per cent or more of plant food had risen to 87 per cent. During that same five-year period, the percentage of the total tonnage represented by the 2-12-6 grade increased from 32 per cent in 1934 to 57.6 per cent in 1939, whereas the percentage of the tonnage represented by the 2-12-6 grade. declined from 30.8 per cent in 1934 to 7.1 per cent in 1939. There were other changes in the use of grades but these two represent the major portion of the shift.

Changing Philosophy As To Fertilizer Use

Dr. Charles E. Thorne started and conducted the second oldest fertilizer experiments in America and in the early years of these experiments, let us say prior to 1910, the great need for phosphate on Ohio soils was the important fact developed. Dr. Thorne preached the use of superphosphate and as a result of his preaching a tremendous quantity was used on Ohio farms. I would want to be the last person to criticize Doctor Thorne, either as to his conclusion or as to his accuracy of the use of superphosphate. He was absolutely right.

But having used the phosphate and having increased crop yields through its use, other plant food elements were withdrawn more rapidly, potash in particular, and so the increase of potash in Ohio fertilizers is entirely logical and based on experimental results. There was also developed, of course, a need for nitrogen, and although a great deal of nitrogen is obtained through the growing of legumes, there is a place for it both in fertilizer mixtures and for its use as side and top dressing.

I believe it is safe to say that agronomists, not only in Ohio but in other States, are now paying more attention to the use of balanced fertilizers. They are beginning to think more about fertilizing the crop rotation than about the fertilizing of individual crops. They are urging the building up of soil organic matter, the use of lime where needed, and other good farm practices.

Fertilization of the corn crop is one of the big problems of the Middle West since up to now only relatively small fertilizer applications have been made on corn. For example, it is estimated that in Ohio only 56 per cent of the corn is fertilized at an average rate of 129 pounds of fertilizer per acre. Many of us think that one of the best ways of fertilizing the corn crop is to make a heavy application on the grain crop that precedes the corn in the rotation, thereby not only getting an increased yield of grain, but a better crop of clover, which means organic matter to plow under and more nitrogen.

Progress in the Application of Fertilizer

No State has made a larger contribution to the experimental program that has been developed during the past ten years to determine the best methods of applying fertilizers. Experiments with corn planters were started in 1929 by Prof. Robert M. Salter and Prof. C. O. Reed and their studies had much to do with the improvement of corn planters that has been made since that date.

Some idea as to the improvement that has taken place in corn planters may be obtained from an experiment which was conducted at Wooster, Ohio, during the past season. Without fertilizer the yield was 23 bushels, about half sound corn and about half nubbins. The yield with 200 pounds of fertilizer applied with the old-type planter was 42 bushels. That, of course, was an increase of 19 bushels and a very satisfactory return from 200 pounds of fertilizer. However, when the same fertilizer was applied with a new-type planter which placed the fertilizer at the sides of the hill, the yield was 48 bushels. When fertilizer was used at the 100 pound rate the yield was 33 bushels with the old-type planter and 41 bushels with the new-type, a difference of eight bushels for method of application. These yields are. of course, quite low, owing to the fact that the weather was very unfavorable to corn production during a large part of the growing season. Nevertheless, an increase of 6 to 8 bushels merely for method of application means that a farmer who does not have an improved corn planter can well afford to buy one.

There is great need for definite information with respect to the fertilization of the soybean crop and new experiments are being planned for the coming year. Potato planters and transplanters have also been improved and are now in most cases quite satisfactory, but practically every year farm equipment manufacturers are improving their machines in one respect or another.

Profits From Fertilizer Use

You are, no doubt, quite familiar with the results obtained in the survey which was made in 1938 by The National Fertilizer Association, but it will, perhaps, be in order to present a few figures to show the returns that Ohio farmers are getting from the dollars that they spend for fertilizers. That survey showed that when an Ohio farmer spends a dollar for corn fertilizer, he gets back $3.22 worth of corn. In other words, he gets his dollar back and $2.22 in addition; not all profit,

(Continued on page 24)

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PIONEER JOURNAL OF THE FERTILIZER INDUSTRY

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NEW BOOK ON FERTILIZER DEFICIENCY SYMPTOMS

Through the cooperative efforts of the Plant Food Research Committee of The National Fertilizer Association and the Committee on Fertilizers of the American Society of Agronomy, a new book on fertilizer deficiency symptoms, entitled "Hunger Signs in Crops," will be ready for distribution in the near future.

The notable feature of this volume, which contains 300 pages, is the 80 pages of color plates showing in faithful reproduction the actual appearance of various crop plants in a healthy state and as they appear when suffering from a deficiency of one or more plant foods. The editorial committee has spent the past five years in assembling color photographs and paintings, as well as many other black and white illustrations to be included in this book.

The nine chapters cover deficiency symptoms on the following crops: tobacco; cotton; corn and small grains; potatoes; vegetable crops; legume crops; deciduous fruits; citrus fruits; and an introductory chapter on "what hunger signs are, how they are studied and what they mean." The various chapters have been written by outstanding agronomists of the U. S. and State Departments of Agriculture, who are authorities on the different crops about which they write.

By printing a large edition the price of the volume has been kept at an extremely low figure of $2.00 on orders placed in advance of publication. The price after publication will be $2.50. Advance orders should be sent to The National Fertilizer Association, Investment Building, Washington, D. C.

COOP. G. L. F. MOVES OFFICES

Cooperative G. L. F. Soil Building Service, Inc., announced the change of its headquarters from 21 West Street, New York City, to the G. L. F. Building, Terrace Hill, Ithaca, N. Y. Purchasing will continue in charge of Joseph L. Batty, Vice-President, at 21 West Street, New York. Factory production, in charge of Albert Spillman, Vice-President, will be transferred to the office of Fertilizer Manufacturing Cooperative, Inc., 1800 Clinton St., Baltimore, Md. Headquarters of L. M. Oliver, in charge under Mr. Stroman, of the five New York State fertilizer mixing plants will be changed from Phelps, N. Y., to Ithaca, N. Y. Mr. Milliman had previously moved his headquarters to Ithaca.

PLANT NUTRITION PAPER AWARDED SCIENTISTS' PRIZE

At the recent meeting of the American Association for the Advancement of Science, held at Philadelphia, the $1,000 prize of the Association was awarded to Professor D. R. Hoagland and Dr. D. I. Arnon, of the University of California, for their paper entitled "Availability of Nutrients with Special Reference to Physiological Aspects."

The paper concerned largely the role of micro-nutrients in plant growth. These are elements which occur in the soil in extremely small amounts are used by the plant, sometimes in solutions as weak as one part in 100,000,000, but without which the plant cannot prosper. The other important aspect of the research is that it forms part of the basis of the new understanding of the food-absorbing process as dynamic instead of static.

The newest element which California scientists found essential to plant life is molybdenum. It is present in so small a quantity that it cannot be a component of chemical salts in the plant cells. It undoubtedly acts as a catalyst, they said, bringing about chemical combinations by its mere presence without taking any place in resulting compounds.

RAFFERTY RETIRES FROM H. J. BAKER & BRO.

H. J. Baker & Bro. have announced the retirement of Charles D. Rafferty from partnership in that firm, as of January 1, 1940. The business of the firm will be continued by the other partners, H. V. B. Smith and H. S. McCormick, and all liabilities of the old firm will be assumed by the new organization.

N. C. MANUFACTURERS GIVE EXTRA PLANT FOOD VALUE

In a report by D. S. Coltrane, Assistant to the North Carolina Commission of Agriculture, he states that during the spring season of 1940, North Carolina received in their fertilizers extra plant food over and above the guaranteed analyses, to the value of $358,476. Due to the reduction of tobacco acreage, consumption of fertilizers decreased about 12 per cent. Out of 3,635 inspections, covering 3,849 samples drawn, only 22 lots of fertilizers were seized for violations of the law. Said Mr. Coltrane: "Seizures were considerably less than half the seizures made in the same period of 1939."

NORTH CAROLINA TOBACCO BRINGS BETTER PRICES

North Carolina farmers sold 466,587,763 pounds of producers' tobacco to December 1st for $81,365,551 or an average of $17.44 per hundred pounds, J. J. Morgan, statistician of the State Department of Agriculture, reported recently.

"Last year, through November 30th, growers had sold 693,582,463 pounds of leaf for an average of $15.98 per hundred.

"Tobacco sales this year compared with corresponding sales periods last year show a decrease of 35 per cent in poundage and an increase of $1.46 per hundred pounds or nine per cent in average price paid," he said. "Producers received $110,862,356 for leaf through November 30, 1939, a decrease of 27 per cent compared with 1940 sales."

November producers' sales totaled 73,274,312 pounds compared with 210,644,281 marketed during the same month last year. The average price of $14.32 per 100 pounds paid growers last month was $5 per hundred less than the October price this year and $2.77 under the November, 1939, average.

NEW YORK ADDS 8-16-12 GRADE

At the conference which was held recently at Ithaca, New York, it was voted that the 2-4-3 ratio should be added to the recommended list and that the grade to be offered under this ratio should be 6-12-9. Since the meeting, Prof. G. J. Raleigh, of the Division of Vegetable Crops, who was unable to be present when the subject was discussed, has requested that the 8-16-12 grade be included also under this ratio. Professor Worthen feels that the grade should be added, and will shortly advise manufacturers selling in New York as to time of publication and price of the leaflet giving the recommendations for 1941.

E. W. WAMPLER RETIRES

After spending thirty-eight years in the fertilizer industry, Ernest W. Wampler of Dayton, Ohio, has sold his entire holdings in the Miami Fertilizer Company and will devote his time to his various private interests. Mr. Wampler with his family will spend the next three months vacationing in the South. His permanent address will be 1423 Glendale Ave., Dayton, Ohio.

Fertilizer Exports and Imports

Exports

Exports of fertilizers and fertilizer materials from the United States in November amounted to 116,416 long tons, with a stated valuation of $1,557,440. Export tonnage was 47 per cent above November, 1939, but 21 per cent under the corresponding month of 1938. There were marked increases over last year in ammonium sulphate, other nitrogenous chemicals, and phosphate rock. A large part of the month's shipments af ammonium sulphate went to the Netherlands Indies, Union of South Africa, and the Canary Islands. Great Britain, Portugal, and Japan were the principal customers for phosphate rock.

Volume of total exports in the first 11 months of the year was 13 per cent below the corresponding period of last year. An increase of nearly 100,000 tons in shipments of ammonium sulphate and a marked increase in exports of superphosphate were more than offset by declines in land pebble rock and potash salts.

Imports

Fertilizer imports in November were comparatively small, amounting to 60,310 long tons, valued at $1,241,604. This was a decline of 45 per cent in tonnage and a similar drop in value. The decrease in nitrogenous materials was due to the fact that not only were there no imports of ammonium nitrate mixtures, calcium nitrate, guano, urea and calurea, castor bean pomace, and fish scrap and meal, but nitrate of soda was brought in in much smaller volume. Muriate of potash, totaling 5,620 tons, shipped from Spain, and 5 tons of other potash materials from Canada were the only items imported in the potash group during November.

January-November imports were 3 per cent below the same period in 1939, and were substantially under the corresponding period for recent years. All phosphate materials showed decreases from the preceding year. Sodium nitrate imports for 11 months were larger, but nitrogenous materials as a group declined. Imports of potash materials were up somewhat.

Exports and Imports of Fertilizers and Fertilizer Materials—Long Tons

EXPORTS	November			January-November		
	1940	1939	1938	1940	1939	1938
Nitrogenous materials	15,891	7,538	20,207	241,119	152,152	183,371
Phosphate rock	84,535	45,822	107,760	654,452	918,858	1,049,491
Other phosphate materials	3,874	9,187	15,579	142,693	110,878	113,475
Potash salts	11,270	12,751	3,080	76,077	116,995	71,177
Other fertilizers	846	3,972	961	31,821	25,178	17,768
Grand Total	116,416	79,270	147,587	1,146,162	1,324,061	1,435,282

IMPORTS	November			January-November		
	1940	1939	1938	1940	1939	1938
Sodium nitrate	28,478	66,407	4,851	636,703	544,872	544,794
Other nitrogenous materials	21,299	30,016	43,186	284,318	442,943	442,056
Phosphate materials	3,680	7,432	6,046	75,570	89,593	45,995
Potash salts	5,625	4,214	58,730	237,162	192,657	312,589
Other fertilizers	1,228	1,322	1,351	36,686	46,112	61,171
Grand Total	60,310	109,391	114,164	1,270,439	1,316,177	1,406,605

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FERTILIZER MATERIALS MARKET

NEW YORK

Holiday Lull in Materials Market. Prices Remain Level Except for Decline in Dried Blood. Scarcity of Sulphate of Ammonia and Triple Superphosphate.

Exclusive Correspondence to "The American Fertilizer."

NEW YORK, December 31, 1940.

During the past two weeks the fertilizer materials market has been noticeably marked by the usual holiday business lull, and activity in this market was at a very low point. The only price change to be noted is in domestic Dried Blood, which shows an advance of 5 cents per unit. All other materials are maintaining previous levels, with sulphate of ammonia remaining in a very strong position.

The export demand is at a minimum with practically no activity to be noted here.

Nitrate of Soda

$29.40 per ton in 100-lb. bags, $28.70 in 200-lb. bags, and $27.00 in bulk, all f.o.b. port warehouse. Supplies continue to be ample and movement of material is strictly against contract.

Sulphate of Ammonia

This market is still very strong and demand continues to exceed supply. Domestic price remains unchanged at $28.00 per ton, port basis; but suppliers are holding for around $40.00 per ton in 200-lb. bags, f.a.s., for export. However, due to freight difficulties, not much export business is being done.

Tankage

This market continues steady with domestic productions fertilizer grade material being held at $2.50 ($3.04 per unit N) and 10 cents, f.o.b. However, demand in this direction is light. Due to freight difficulties, there are very few offerings of this material from the South American producers.

Dried Blood

The local market shows a firming up with last sales reported at $2.25 (2.73½ per unit N), f.o.b.This represents an advance of 5 cents over previous business. Further offerings of local productions are being held at $2.30 ($2.79½ per unit N), f.o.b. South American blood has recently been quoted at $2.45 ($2.98 per unit N), c.i.f., Atlantic Ports, but no new business has been reported from this source.

Nitrogenous Material

This market remains in the doldrums and the only activity to be noted is a small movement of material against previous contracts.

Bone Meal

Strictly nominal in the lack of offerings. South American 4½ and 50 per cent grade can be bought at from $30.00 to $33.00 per ton, c.i.f.

Fish Scrap

No activity here because of lack of supplies. There are still no offerings on the market of Japanese fish meals.

Superphosphate

Ordinary superphosphate remains reasonably firm at from 52 cents to 54 cents per unit A.P.A., bulk basis, f.o.b. New York area. Triple superphosphate is still in a very strong position because of the inability of producers to meet the demand for this commodity.

Potash

Current schedule prevails at 53½ cents per unit K_2O, bulk basis, ex vessel. Supplies continue to be adequate and brisk movement of material against contract is to be noted at this time.

The American Agricultural Chemical Company is planning to make additions to its Baltimore acid plant. Two new acid chambers and an acid tower will be erected, at a cost of $23,000.

FERTILIZER MATERIALS

■

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BALTIMORE

Market Lacks Outstanding Feature. Organics Slightly Easier. Bag Prices Advance.

Exclusive Correspondence to "The American Fertilizer."

BALTIMORE, December 31, 1940.

There have not been any outstanding features in connection with the market on Fertilizer materials during the past two weeks.

Ammoniates.—Tankage for feeding purposes is again ruling slightly easier, and ranges from $2.90 to $3.00 per unit of nitrogen, with South American ground dried blood easing off to $2.90 per unit of nitrogen, c.i.f. Atlantic ports, but with very little interest being shown.

Nitrogenous Material.—The market on this article continues quiet and prices are still nominally $2.55 to $2.65 per unit of nitrogen f.o.b. Baltimore.

Sulphate of Ammonia.—There has been practically no activity in resale material for domestic use, but the market for export is gradually working up firmer, with offerings few and far between, ranging form $42.00 to $45.00 per ton, in double bags, f.a.s. Baltimore.

Nitrate of Soda.—There has not been any change in the situation, and importers of the Chilean Champion brand quote 100-lb. bags at $29.40 per ton of 2,000 lb., ex port warehouse, and in 200-lb. bags at $28.70, while for shipment in bulk the price is $27.00. The demand continues light, as is usual at this time of the year.

Fish Meal.—This material is in short supply, and such re-sale lots of Japanese sardine meal as are obtainable, are quoted at $59.00 to $60.00 per ton, f.o.b. Baltimore.

Superphosphate.—There have been no heavy stocks accumulating in the hands of the manufacturers who continue to quote $8.00 per ton, basis 16 per cent for run-of-pile, and $8.50 per ton for flat 16 per cent, both in bulk, per 2,000 lbs., f.o.b. producers' works, Baltimore, and no immediate change anticipated.

Bone Meal.—The demand continues light, and the market on 3 and 50 per cent steamed bone meal ranges from $32.00 to $34.00 per ton, f.o.b. Baltimore, according to mechanical condition. South American 4½ and 47 per cent raw bone meal is quoted at $30.00 to $32.00 per ton, c.i.f. Baltimore.

Potash.—Most of the manufacturers have now taken in their requirements for the coming spring season, and no serious shortage is expected. Such re-sale lots as are obtainable are limited, and held around 55 cents per unit, for muriate in bulk.

Bags.—The market on bags is again higher and the price for plain, new, 10-oz., basis 40, cut 54 in., is about $119.50 per thousand, f.o.b. Baltimore, for spring delivery.

ATLANTA

Holiday Season Affects Market. Prices Practically Unchanged. Ample Supply of All Essential Fertilizer Ingredients.

Exclusive Correspondence to "The American Fertilizer."

ATLANTA, December 30, 1940.

There has been little activity in the market on fertilizer materials during the holiday period and prices are practically unchanged.

Sulphate of amonia is in good demand with supplies by no means plentiful. There is also a better demand for potash, especially for export.

With the approach of the spring fertilizer season, there does not seem to be any acute shortage of any of the essential fertilizer ingredients and prices on the average are no higher than they were a year ago, so agriculture in this country should be adequately taken care of from the fertilizer standpoint without any

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added burdens or exhorbitant prices being asked.

The market generally is as follows:

South American Blood.—$2.50 ($3.04 per unit N), c.i.f.

South American Tankage.—$2.65 ($3.22 per unit N) and 10 cents, c.i.f.

Domestic Nitrogenous.—$1.85 ($2.25 per unit N), producing points.

Sulphate of Ammonia.—Demand active, prices unchanged.

Nitrate of Soda.—Unchanged

Cottonseed Meal.—Prime 8 per cent $28.50, Memphis; southeastern mills, $1.50 per ton higher.

Steamed Bone Meal.—3 and 50 per cent $31.50.

Raw Bone Meal.—4½ and 45 per cent, $31.50

WILMINGTON

Interest in Materials Increasing. Menhaden Catch Very Disappointing with Prices High. Cottonseed Dealers Hold Large Stock of Meal.

Exclusive Correspondence to "The American Fertilizer."

WILMINGTON, December 30, 1940.

Interest in materials has improved with the closing of the Old Year. Many of the independent manufacturers find that they have yet to cover on some organics and a little demand is showing for potash.

The fishing season is over, or practically so, in Carolina waters, with a number of the fishing companies finding themselves unable to fill contracts for scrap that have been made for some time. It has been about the poorest season they have had in years and as a result there is a strong demand for material at prices that would be very attractive—if they had anything to sell. If the weather is good during January, they might still be able to catch more fish before definitely closing for the season.

Cottonseed meal is somewhat weaker on poor demand. The mills have large stocks but such stocks for the most part are the property of seed dealers and the mills have little of their own to sell. It would seem that if the fertilizer manufacturers do not take meal from their dealers on fertilizer account—and the present holders of the meal have to sell it to the mills—there should be a further weakening in the market.

Prospects for tonnage in 1941 indicate that the movement will be about the same as in 1940.

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CHICAGO

Fertilizer Organics Market Quiet with Prices Generally Steady. Feed Materials Firmer after Recent Break.

Exclusive Correspondence to "The American Fertilizer."

CHICAGO, December 30, 1940.

While the organic market is dormant as the year ends, prices are holding fairly steady.

No new offerings have appeared, and sellers repeat their previous assertions that they are well sold up to production. Fertilizer tankage did decline somewhat, but that evidently was only in keeping with the lower market for feed tankage.

After the rather severe break in feed materials, a firmer feeling developed. Increased consuming demand encouraged mixers to advance their bids.

Nominal prices are as follows:

High grade ground fertilizer tankage, $2.20 to $2.25 (2.67½ to $2.73½ per unit N) and 10 cents; standard grades crushed feeding tankage, $2.50 to $2.60 ($3.04 to $3.16 per unit N) and 10 cents; blood, $2.60 to $2.65 ($3.16 to $3.22 per unit N); dry rendered tankage, 50 to 55 cents per unit of protein, Chicago basis.

PHILADELPHIA

Market Quiet and Contract Deliveries Lighter than Usual. Prices Remain Firm.

Exclusive Correspondence to "The American Fertilizer."

PHILADELPHIA, December 31, 1940.

There is practically no interest being displayed in fertilizer materials at this time, and deliveries against contracts are lighter during these last few days of December.

Nitrate of Soda.—Quiet. Price, $27.00 in bulk, $28.70 in 200-lb. bags and $29.40 in 100-lb. bags, in carload lots.

Sulphate of Ammonia.—Strong. Shipments against contracts normal. Export demand continues.

Dried Blood.—Steady at $2.40 to $2.50 per unit of ammonia ($2.91½ to $3.04 per unit N).

Tankage.—Firm at $2.60 to $2.70 per unit of Ammonia ($3.16 to $3.28 per unit N) and 10 cents per unit of B.P.L.

Bone Meal.—Strong. Demand good. 1 and 65 per cent about $36.00; 3 and 50 per cent at $32.50 c.i.f.; 4½ and 45 per cent at $35.00 to $36.00.

Superphosphates.—Price remains the same. Deliveries against contracts increasing.

Potash.—Schedule prevails.

BAD YEAR FOR WHEAT CAUSES PREMIUM DEFICIT

Crop insurance last year offset heavy losses by wheat growers, particularly in four of the largest producing states where near-record abandonments occurred, says Leroy K. Smith, manager of the Federal Crop Insurance Corporation.

Unusually large abandonments in Nebraska, Texas, Kansas, and Oklahoma, Mr. Smith said, accounted for the greatest part of about 22,000,000 bushels in indemnities paid farmers throughout the country under the 1940 crop insurance program. The growers paid premiums for their protection with almost 15,000,000 bushels of wheat, but the corporation paid out about 7,000,000 bushels more than it took in.

Mr. Smith emphasized that excessive acreage abandonments such as occurred this year will not take place every year, and that when the wheat belt experiences a year of average yields, premium collections can be expected to exceed indemnity payments.

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See Page 4

Farmers' Expenditures for Fertilizer

Important new information on the total fertilizer bill of American farmers has been made available in a recent report of the U. S. Department of Agriculture, entitled "Farmers' Expenditures for Fertilizer and Agricultural Lime." This report is one of a series issued by the Department on Expenses of Agricultural Production, which in turn is part of a broad study of Income Parity for Agriculture.

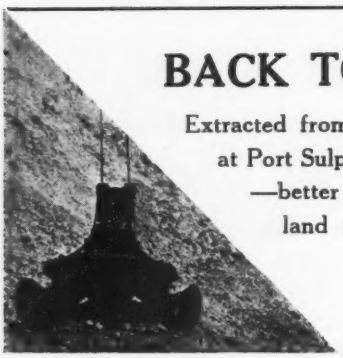
Basic data from the report are given in the accompanying table. These figures are based on commercial fertilizer only, excluding purchases of lime, limestone, gypsum, marl, and manure. Statistics contained in the report supersede estimates which had been issued in previous years.

The report concludes by stating that: "The average prices paid by farmers for fertilizer

Fertilizer Sales, Prices and Farmers' Expenditures

Year	Fertilizer Tonnage (Thousands)	Average Price per Ton	Farmers' Expenditures for Fertilizer* (Millions of $)	Total Farm Cash Income (Millions of $)	Expenditures for Fertilizer in % of Farm Income
1910	5,453	$24.53	143	5,785	2.47
1911	6,024	24.53	159	5,581	2.85
1912	5,767	24.68	153	5,966	2.56
1913	6,337	25.20	172	6,251	2.75
1914	7,100	25.68	197	6,015	3.28
1915	5,324	27.55	159	6,391	2.49
1916	5,125	29.67	165	7,755	2.13
1917	5,926	33.80	218	10,648	2.05
1918	6,467	41.96	297	13,464	2.21
1919	6,626	44.87	326	14,436	2.26
1920	7,177	45.97	359	12,553	2.86
1921	4,863	38.57	203	8,107	2.50
1922	5,671	31.78	193	8,518	2.27
1923	6,443	30.56	210	9,524	2.20
1924	6,826	29.14	210	10,150	2.07
1925	7,334	29.72	229	10,927	2.10
1926	7,329	29.62	227	10,529	2.16
1927	6,844	28.77	205	10,699	1.92
1928	7,986	32.36	267	11,024	2.42
1929	8,012	32.46	268	11,221	2.39
1930	8,222	31.26	264	8,883	2.97
1931	6,354	28.30	184	6,283	2.93
1932	4,385	25.15	113	4,682	2.41
1933	4,908	23.36	118	5,409	2.18
1934	5,583	26.77	152	6,720	2.26
1935	6,274	26.50	170	7,542	2.25
1936	6,902	25.83	182	8,499	2.14
1937	8,196	27.55	232	9,111	2.55
1938	7,489	26.90	209	8,072	2.59
1939	7,589	27.55	218	8,540	2.55

* In arriving at the expenditure figures the Department made adjustments to make the data conform with Census reports. The value of fertilizer furnished by Agricultural Adjustment Administration under grant-by-aid program is included, amounting to 1 million dollars in 1937, 2 millions in 1938, and 5 millions in 1939.



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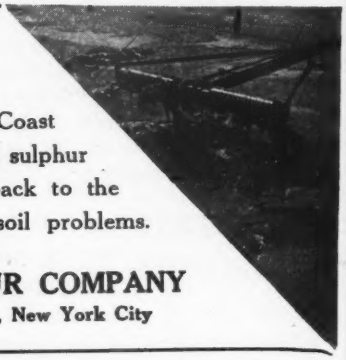

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have fluctuated considerably since 1909 but since the World War have tended generally to decline. This downward trend in fertilizer prices together with the increasing percentage of plant food content has resulted in a considerable reduction in the price per unit of plant food."

The price paid for plant food has of course declined much more than has the price paid per ton of fertilizer, since there has been a substantial rise in the average plant food content. Tonnage in 1940 is about 42 per cent greater than it was in 1910, but the tonnage of actual plant food purchased is 87 per cent larger. Expenditures for fertilizer, however, are only 52 per cent larger.

There is a close correlation between farm cash income and the amount of money spent for fertilizer. It is stated in the report that: "On the basis of the data for more recent years it appears that farmers are basing their purchasing programs more on the prospects for future incomes and less on incomes of the preceding year than they did formerly."

TAG SALES

(Continued from page 9)

rise for the area as a whole amounting to 15 per cent. This marked a new peak in annual sales in that territory. The trend of fertilizer consumption is still upward in the newer fertilizer-using areas, while it has leveled off in the South, where a retarding influence in recent years has been the reduction of cotton and tobacco acreage.

The increase in fertilizer consumption in 1940 coincided with an increase in farm cash income, continuing the relationship of past years. In each of the last ten years farm income and fertilizer consumption have moved in the same direction. Both dropped sharply in 1931 and 1932; recovery took place in each of the next five years in both; declines occurred in 1938 and moderate upturns followed in 1939 and 1940.

Further recovery in farm income is forecast by the Department of Agriculture for 1941. Based on past relationships, this should mean another increase in fertilizer tonnage. Price relationships are favorable to increased use of fertilizer. Prices received by farmers in December were 105 per cent of parity with fertilizer, according to the Department's reports.

TRENDS IN FERTILIZER MANUFACTURE AND USAGE

(Continued from page 11)

of course, but very largely profit. When he spends a dollar for wheat fertilizer, he gets back $1.79 worth of wheat and in addition to that he gets the benefit on the clover crop which follows wheat, which is often sufficient to pay for the fertilizer. When he spends his dollar for potato fertilizer, he gets back $3.04; for tobacco fertilizer, $11.07; for sugar beet fertilizer, $6.71; and for tomato fertilizer, $6.76. The average figure for all crops is $2.40, or $1.40 in addition to the cost of the fertilizer.

If the fertilizer manufacturer could obtain as much profit on a ton of fertilizer that he delivers to the farm as a farmer obtains on a dollar's worth of fertilizer, the manufacturer would be satisfied.

TRULLINGER AND MERRITT HONORED BY AGRICULTURAL ENGINEERS

The American Society of Agricultural Engineers has announced that its Jury of Awards has selected R. W. Trullinger to receive the John Deere Medal, and H. C. Merritt to receive the Cyrus Hall McCormick Medal.

Mr. Trullinger is assistant chief in the office of Experiment Stations, U. S. Department of Agriculture, and his work in organizing and planning research in soils, fertilizers and agricultural engineering, as well as the adequate reporting of their results, won for him the John Deere Medal which is awarded for "distinguished achievement in the application of science and art to the soil."

Mr. Merritt is vice-president of the Allis Chalmers Mfg. Company, Milwaukee, and has been outstanding for his persistent efforts to reduce the major farm machines in size and cost, so that they would be available to the mass market of small farms, with profit to producer and purchaser alike.

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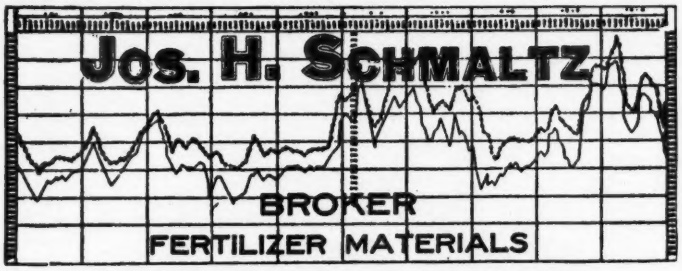

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KEYSER BUILDING

BORON DEFICIENCY IN MAINE CABBAGE

Bulletin 402 of the Maine Agricultural Experiment Station, entitled "Boron Deficiency Symptoms in Some Plants of the Cabbage Family," reports that boron deficiency has been observed in the soil in several sections of southern and eastern Maine. As a consequence, plants of the cabbage family, including broccoli, brussels sprouts, cauliflower, kale, rutabagas and turnips, have been dwarfed and show curled, rolled leaves, often with chlorotic margins. The size and quality of the edible portions are also severely affected. It is interesting to note that the boron deficiency occurred only in those sections which have been cultivated from 150 to 300 years, but was not found in more recently opened areas, such as Aroostook County.

The station recommends the use of 10 pounds of borax per acre, applied with the fertilizer in the row, or as a side dressing, or in solution as a spray. In setting out plants, boric acid solutions may be used, the solution being poured into the holes prepared to receive the plants.

PHOSPHORUS IN HUMAN AND ANIMAL HEALTH

(Continued from page 8)

that of whole corn; rice polish has 1.7 per cent, or more than 10 times as much as the polished rice kernel; wheat bran contains nearly 1.5 per cent. or nearly 4 times as much as whole wheat; and wheat middlings contain about 1 per cent, or 2 or 3 times as much as the whole kernel. Among the oil meals, cottonseed oil meal is the highest with about 1.25 per cent; linseed oil meal has about 0.87 per cent; and soybean oil has 0.6-0.7 per cent.

The forage crops in general are not good sources of phosphorus although they are quite generally fairly good sources of calcium. In general the phosphorus content of all forage crops may be said to vary between 0.1-0.3 per cent on the dry basis. When grown on phosphorus-poor soils, the forages may, and often do, contain less than 0.1 per cent phosphorus. Ohio-grown alfalfa contained 0.22 per cent; Oregon alfalfa averaged 0.24 per cent; 60 samples from Oklahoma averaged 0.16 per cent; while some English alfalfa averaged 0.44 per cent phosphorus. Dr. Carroll furnished me with some figures for the phosphorus content of alfalfa grown in various counties of Utah in 1938. These figures varied from 0.31 to 0.144 per cent on the air dried basis.

Eckles and associates reported (1932) an average of 0.106 per cent phosphorus in 51 samples of prairie hay collected in Minnesota, although two samples had but 0.013 per cent on the air-dry basis. Becker and associates in 1933 reported the following values for the phosphorus content of Florida wiregrass:

Samples from areas in which sweeny or stiffs in cattle occurred contained an average of 0.082 per cent when taken from the burned areas and 0.038 per cent from the unburned areas. From healthy ranges, the phosphorus content of wiregrass was 0.133 per cent. These authors also gave an average figure of 0.103 per cent of phosphorus in grasses for areas outside of Florida where bone chewing occurred, while the corresponding figure for grasses in non-bone-chewing areas was 0.167 per cent. All of these figures are on the dry basis.

For man the chief sources of phosphorus are lean meat, milk and eggs, and the phosphorus content of these, unlike that of the forages, is extremely constant.

For the most part there is such a close relationship between protein and phosphorus that, in general, feeds or foods rich in protein are also rich in phosphorus.

(To be continued in the next issue)

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By GILBERT H. COLLINGS, PH.D., Associate Professor of Agronomy, Clemson Agricultural College. A modern, complete study of all fertilizer problems, well illustrated. The book gives actual research data, and the work of many agronomists, chemists and engineers has been reviewed. Each chapter has been read by authorities connected with organizations producing or marketing the products discussed; thus it represents a composite of the best opinions and conclusions in the fertilizer industry. 365 pages. 85 illustrations. Price $4.00.

Handbook of Fertilizers

By A. F. GUSTAFSON, PH.D., Professor of Soil Technology, Cornell University. A revised edition of this popular treatise. Covers the sources, character and composition of fertilizers and fertilizer materials. The food requirements of different crops and the effects of different fertilizers. A valuable volume for fertilizer manufacturers and salesmen, county agents, agricultural teachers, farmers and truckers. 172 pages. 5 x 8. Price $1.75.

Manures and Fertilizers

By H. J. WHEELER. A clear and unusually full discussion of the practical utilization of manures and fertilizers of all kinds and of their relations to the plant and to the soil. 389 pages. 5½ x 7½. Illustrated. Price $2.75.

Phosphoric Acid, Phosphates and Phosphatic Fertilizers

By W. H. WAGGAMAN. A comprehensive treatise, covering completely the subjects of phosphoric acid and phosphate—the sources, the processes of treatment, the products obtained, and their uses in agriculture and the arts. The volatilization process for producing phosphoric acid is fully discussed. In addition to the use of phosphate as a fertilizer material, there are chapters on phosphate baking powders, phosphate water softeners, and miscellaneous uses. This book is one of the American Chemical Society's technologic monographs and contains extended references to the literature, which facilitates further study of the subject. 366 pages. Price $5.75.

Potash Deficiency Symptoms

By OSKAR ECKSTEIN, ALBERT BRUNO AND J. W. TURRENTINE. A revised edition which explains in detail the signs of potash deficiency in all the important cultivated crops as shown in appearance and structure of leaf, root, fruit, etc.; also the influence of a lack of potash on resistance to plant diseases, pests and climatic factors. Printed in English, French and German. Profusely illustrated with 55 color plates and 41 black and white engravings. 248 pages. 7 x 9½. Price $2.25.

Potash: A Review, Estimate and Forecast

By J. W. TURRENTINE, M.S., PH.D., in charge of Potash Investigations, Bureau of Soils, U. S. Department of Agriculture. This book, written by an authority on the subject, covers in detail the American and foreign potash industry. This book deals with the technology of potash manufacture from numerous raw materials; the occurrence, properties and relative values of various potash minerals and the technology of extraction; the technology of utilizing potash-bearing industrial wastes for the manufacture of potash salts. European and other foreign sources of supply are given special attention. 188 pages. 6 x 9. Illustrations and tables. Price $3.00.

Soil Management

By FIRMAN E. BEAR, PH.D. This is a revised and enlarged edition of a book which was an accepted text book in schools with agricultural courses, and which also enjoyed a wide general circulation. The author has made a study of soils for many years, both in this country and in Europe. The 26 chapters cover five divisions of the subject—requirements of soils, characteristics of soils, utilizing soil resources and supplementing soil resources. The last division treats most effectively of fertilizers. 412 pages. 6 x 9. 58 figures. Price $3.50.

Sulphuric Acid Manufacture

By ANDREW M. FAIRLIE. This volume covers thoroughly the production of sulphuric acid from its earliest beginnings to the latest developments in both chamber and contact systems. Modern apparatus, plant construction and production methods are described in detail, with numerous illustrations. Other chapters are also included on the production of raw materials as well as the uses, handling methods, cost accounting methods, etc., of the finished product. An American Chemical Society Monograph. 632 pages. 6 x 9. Price $9.75.

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By FIRMAN E. BEAR, PH.D. Second revised edition, covering the progress in the manufacture and use of fertilizers during recent years. The history of the science of fertilizers from the time of Jethro Tull to the present era. Fertilizer practice, both in Europe and America, is completely examined. The various schemes that have been proposed for determining what fertilizers to use are thoroughly treated. A comparison of fertilizers and their relative values is made. Also, there are concise statements of determining the fertilizer needs, and specific suggestions as to the use of fertilizers. 360 pages. 6 x 9. Price $4.00.

Any of the above sent postpaid on receipt of price. A full list of books on these subjects sent free on request.

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A CLASSIFIED INDEX TO ALL THE ADVERTISERS IN "THE AMERICAN FERTILIZER"

This list contains representative concerns in the Commercial Fertilizer Industry, Including fertilizer manufacturers, machinery and equipment manufacturers, dealers in and manufacturers of commercial fertilizer materials and supplies, brokers, chemists, etc.
For Alphabetical List of Advertisers, see page 33.

ACID BRICK
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.

ACID EGGS
Chemical Construction Corp., New York City.

ACIDULATING UNITS
Chemical Construction Corp., New York City.
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BAGS—Dealers and Brokers
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A Classified Index to Advertisers in "The American Fertilizer"

BUYERS' GUIDE

For an Alphabetical List of all the Advertisers, see page 33

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Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.

BURNERS—Sulphur
Chemical Construction Corp., New York City.

BURNERS—Oil
Monarch Mfg. Works, Inc., Philadelphia, Pa.
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CABLEWAYS
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Synthetic Nitrogen Products Co., New York City.

CAL-NITRO
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Sackett & Sons Co., The A. J., Baltimore, Md.
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CASTINGS—Iron and Steel
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Fairlie, Andrew M., Atlanta, Ga.

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Baker & Bro., H. J., New York City.
Barrett Company, The, New York City.

CHEMICALS—Continued
Bradley & Baker, New York City.
Du Pont de Nemours & Co., E. I., Wilmington, Del.
Huber & Company, New York City.
Wellmann, William E., Baltimore, Md.

CHEMICAL PLANT CONSTRUCTION
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CHEMISTS AND ASSAYERS
Gascoyne & Co., Baltimore, Md.
Shuey & Company, Inc., Savannah, Ga.
Stillwell & Gladding, New York City.
Wiley & Company, Baltimore, Md.

CLUTCHES
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CONCENTRATORS—Sulphuric Acid
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.

CONDITIONERS AND FILLERS
American Limestone Co., Knoxville, Tenn.
Phosphate Mining Co., The, New York City

CONTACT ACID PLANTS
Chemical Construction Corp., New York City.

COTTONSEED PRODUCTS
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
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Schmaltz, Jos. H., Chicago, Ill.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

CRANES AND DERRICKS
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.
Link-Belt Speeder Corp., Chicago, Ill. and Cedar Rapids, Iowa.
Sackett & Sons Co., The A. J., Baltimore, Md.

CYANAMID
American Agricultural Chemical Co., New York City.
American Cyanamid Co., New York City.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Jett, Joseph C., Norfolk, Va.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

DENS—Superphosphate
Chemical Construction Corp., New York City.
Stedman's Foundry and Mach. Works, Aurora, Ind.

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CHEMICAL ENGINEER
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DRYERS—Direct Heat
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Sackett & Sons Co., The A. J., Baltimore, Md.

DRIVES—Electric
Link-Belt Company, Philadelphia, Chicago.

DUMP CARS
Link-Belt Company, Philadelphia, Chicago.
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Sackett & Sons Co., The A. J., Baltimore, Md.

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Atlanta Utility Works, East Point, Ga.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
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ELEVATORS AND CONVEYORS—Portable
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

ENGINEERS—Chemical and Industrial
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

ENGINES—Steam
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

EXCAVATORS AND DREDGES—Drag Line and Cableway
Hayward Company, The, New York City.
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FERTILIZER MANUFACTURERS
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Armour Fertilizer Works, Atlanta, Ga.
Farmers Fertilizer Co., Columbus, Ohio.
International Agricultural Corp., New York City.
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FOUNDERS AND MACHINISTS
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
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Stedman's Foundry and Mach. Works, Aurora, Ind.

GARBAGE TANKAGE
Wellmann, William E., Baltimore, Md.

GEARS—Machine Moulded and Cut
Jeffrey Manufacturing Co., The, Columbus, Ohio.
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GEARS—Silent
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

GELATINE AND GLUE
American Agricultural Chemical Co., New York City.

GUANO
Baker & Bro., H. J., New York City.

HOISTS—Electric, Floor and Cage Operated, Portable
Hayward Company, The, New York City.
Jeffrey Manufacturing Co., The, Columbus, Ohio.

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IMPORTERS, EXPORTERS
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Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Wellmann, William E., Baltimore, Md.

IRON SULPHATE
Tennessee Corporation, Atlanta, Ga.

INSECTICIDES
American Agricultural Chemical Co., New York City

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Sackett & Sons Co., The A. J., Baltimore, Md.

LIMESTONE
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American Limestone Co., Knoxville, Tenn.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
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Jeffrey Manufacturing Co., The, Columbus, Ohio.
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Sackett & Sons Co., The A. J., Baltimore, Md.

MACHINERY—Acid Making
Atlanta Utility Works, East Point, Ga.
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Chemical Construction Corp., New York City.
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Monarch Mfg. Works, Inc., Philadelphia, Pa.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MACHINERY—Coal and Ash Handling
Hayward Company, The, New York City.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

MACHINERY—Elevating and Conveying
Atlanta Utility Works, East Point, Ga.
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MACHINERY—Tankage and Fish Scrap
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MAGNESIA
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MANGANESE SULPHATE
Tennessee Corportion, Atlanta, Ga.

MIXERS
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Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

NITRATE OF SODA
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Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
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NOZZLES—Spray
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PACKING—For Acid Towers
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Chemical Construction Corp., New York City.

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Schmaltz, Jos. H., Chicago, Ill.
Southern Phosphate Corp., Baltimore, Md.
Taylor, Henry L., Wilmington, Del.
Wellmann, William E., Baltimore, Md.

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PIPES—Wooden
Stedman's Foundry and Mach. Works, Aurora, Ind.

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Fairlie, Andrew M., Atlanta, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

POTASH SALTS—Dealers and Brokers
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
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Wellmann, William E., Baltimore, Md.

POTASH SALTS—Manufacturers and Importers
American Potash and Chem. Corp., New York City.
Potash Co. of America, Baltimore, Md.
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PULLEYS AND HANGERS
Atlanta Utility Works, East Point, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

PUMPS—Acid-Resisting
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Monarch Mfg. Works, Inc., Philadelphia, Pa.

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Sackett & Sons Co., The A. J., Baltimore, Md.

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Wellmann, William E., Baltimore, Md.

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American Agricultural Chemical Co., New York City

TANKAGE
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Wellmann, William E., Baltimore, Md.

TANKAGE—Garbage
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Sackett & Sons Co., The A. J., Baltimore, Md.

TILE—Acid-Proof
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.

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Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.

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UREA-AMMONIA LIQUOR
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